ARIZ 729a
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(5 Pages)

EXCHANGEABLE SODIUM IN TOPSOIL

(An Arizona Method)

SCOPE

1. (a) This test method is used to compare or qualify topsoil for cultivation of plants insofar as the proportion of exchangeable sodium among the four major cations (Sodium, Potassium, Calcium, and Magnesium) is related to plant welfare. "Exchangeable" is defined by the method itself and is based on the exchange of ammonium ion from the reagent Ammonium Acetate Solution with the four major cations under the conditions given by the method. The four cations are brought into solution by the reagent and their concentrations in solution are determined by Atomic Absorption or Flame Emission Spectrophotometry.

(b) This test method may involve hazardous material, operations, or equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

(c) See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

(d) Metric (SI) units and values are shown in this test method with English units and values following in parentheses. Values given for metric and English units may be numerically equivalent (soft converted) for the associated units, or they may be given as rounded or rationalized values (hard converted). Either the metric or English units along with their corresponding values shall be used in accordance with applicable specifications. See Appendix A2 of the Materials Testing Manual for additional information on the metric system.

APPARATUS

2. Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:

(a) 1.70 mm (No. 12) sieve.

(b) A balance or scale capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance or scale utilized shall be at least 0.01 gram.

(c) Plastic vials, 44.45 mm (1-3/4 inch) wide x 76.2 mm (3 inches) tall, with caps.

(d) Reciprocating shaker capable of 180 cycles per minute, with carrier for holding vials in place.

(e) Sodium-free quantitative filter paper, 11 cm diameter.

(f) 10 mL volumetric pipette, accurate to ± 0.05 mL.

(g) Atomic Absorption or Flame Emission Spectrophotometer capable of determining Sodium, Potassium, Calcium, and Magnesium, with high-solids burner head and nitrous oxide acetylene flame capability.

(h) 40 mL volumetric pipette, accurate to ± 0.05 mL.

(i) 5 mL graduated pipette, accurate to ± 0.05 mL.

REAGENTS

3. (a) Ammonium Acetate Solution, 1 Normal. (Measure 57 mL reagent glacial acetic acid into a 1 liter volumetric flask and dilute to 500 mL with deionized water. Add 69 mL reagent concentrated ammonium hydroxide. Dilute to approximately 950 mL with deionized water and mix. Adjust pH to 7.0 using glacial acetic acid or ammonium hydroxide dropwise as necessary. Dilute to the mark with deionized water.)

(b) Sodium Stock Solution, 1000 mg/liter, (available as calibration standard solution from chemical manufacturers).

(c) Potassium Stock Solution, 1000 mg/liter, (available as calibrated standard solution).

(d) Calcium Stock Solution, 1000 mg/liter, (available as calibrated standard solution).

(e) Magnesium Stock Solution, 1000 mg/liter, (available as calibrated standard solution).

PROCEDURE

4. (a) Weigh 2.00 grams of soil, passing a 1.70 mm (No. 12) sieve into a plastic vial.

(b) Pipette 40.0 mL Ammonium Acetate Solution into the vial, and cap it.

(c) Place vial on reciprocating shaker, start shaking at 180 cycles per minute and shake exactly 5 minutes.

(d) Immediately filter into a clean vial. (The folded filter paper can be placed on the rim of the vial instead of using a funnel.) Cap the vial. This is the Original Extract Solution.

(e) Pipette 10 mL of Original Extract Solution into a 100 mL volumetric flask and dilute to the mark with Ammonium Acetate Solution. This is the Diluted Extract Solution.

(f) Prepare a set of three Spectrophotometry Standard Solutions with concentrations of 10.0 mg/liter, 25.0 mg/liter, and 50.0 mg/liter of Sodium by pipetting 1.0 mL, 2.5 mL, and 5.0 mL respectively of Sodium Stock Solution into each of three 100 mL volumetric flasks and diluting to the mark with Ammonium Acetate Solution.

(g) Repeat step 4(f) for Potassium, for Calcium, and for Magnesium, thus preparing a total of twelve Spectrophotometry Standard Solutions.

(h) Perform an Atomic Absorption or Flame Emission Spectrophotometric analysis using the Original Extract Solution, the Diluted Extract Solution, and the Spectrophotometry Standard Solutions as necessary to optimize accuracy on the basis of sensitivity, linearity, and variance of instrument response using Ammonium Acetate Solution as the blank. (The instrumental parameters, given in the table below are recommended for the analysis.) Determine the concentration of each of the four cations in the Original Extract Solution to the nearest 0.1 mg/liter.

ELEMENT	WAVE LENGTH	SLIT	FLAME	BURNER
Sodium	589.2	0.7	Air-Acetylene	3 Slot
Potassium	766.5	0.7	Air-Acetylene	3-Slot
Calcium	422.7	0.7	N_2O-Acetylene	N_2O
Magnesium	285.2	0.7	N_2O-Acetylene	N_2O

CALCULATIONS

5. (a) Calculate the concentration of exchangeable cations in milliequivalents per 100 grams (meq /100 g) of soil using the following formulas:

$$C'_{Na} \text{ (in meq/100 g)} = (0.087) \times (C_{Na})$$

$$C'_{K} \text{ (in meq/100 g)} = (0.051) \times (C_{K})$$

$$C'_{Ca} \text{ (in meq/100 g)} = (0.100) \times (C_{Ca})$$

$$C'_{Mg} \text{ (in meq/100 g)} = (0.165) \times (C_{Mg})$$

Where: C_{Na}, C_K, C_{Ca}, or C_{Mg} is the concentration of each cation, in mg/liter, respectively in the Original Extract Solution.

(b) Compute the total Cation Exchange Capacity (CEC) of the soil, which is the sum of the four exchangeable cation concentrations, as follows:

$$\text{CEC (in meq/100 g)} = C'_{Na} + C'_{K} + C'_{Ca} + C'_{Mg}$$

(c) Compute the Exchangeable Sodium Percentage (ESP), which is the exchangeable sodium proportion of the total Cation Exchange Capacity as follows:

$$ESP = \frac{C'_{Na}}{CEC} \times 100$$

(d) Compute the Exchangeable Sodium (ES) in the soil, in parts per million, using the following formula:

$$ES \text{ (in ppm)} = (20) \times (C_{Na})$$

REPORT

6. (a) Report Exchangeable Sodium Percentage (ESP) to the nearest 0.1 percent.

(b) Report Exchangeable Sodium (ES) to the nearest 1.0 ppm.